Complex Decision-Making Applications for the NASA Space Launch System

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Abstract

The Space Shuttle program is ending and elements of the Constellation Program are either being cancelled or transitioned to new NASA exploration endeavors. NASA is working diligently to select an optimum configuration for the Space Launch System (SLS), a heavy lift vehicle that will provide the foundation for future beyond LEO large-scale missions for the next several decades. Thus, multiple questions must be addressed: Which heavy lift vehicle will best allow the agency to achieve mission objectives in the most affordable and reliable manner? Which heavy lift vehicle will allow for a sufficiently flexible exploration campaign of the solar system? Which heavy lift vehicle configuration will allow for minimizing risk in design, test, build and operations? Which heavy lift vehicle configuration will be sustainable in changing political environments?

Seeking to address these questions drove the development of an SLS decision-making framework. From Fall 2010 until Spring 2011, this framework was formulated, tested, fully documented, and applied to multiple SLS vehicle concepts at NASA from previous exploration architecture studies. This was a multistep process that involved performing FOM-based assessments, creating Pass/Fail gates based on draft threshold requirements, performing a margin-based assessment with supporting statistical analyses, and performing sensitivity analysis on each. This paper discusses the various methods of this process that allowed for competing concepts to be compared across a variety of launch vehicle metrics. The end result was the identification of SLS launch vehicle candidates that could successfully meet the threshold requirements in support of the SLS Mission Concept Review (MCR) milestone.